

0021887

Department of Energy

9204804

Richland Field Office

P.O. Box 550

Richland, Washington 99352

JUN 26 1992

92-WOB-223

Mr. David B. Jansen, P. E.
Hanford Project Manager
State of Washington
Department of Ecology
P.O. Box 47600
Olympia, Washington 98504-7600

Dear Mr. Jansen:

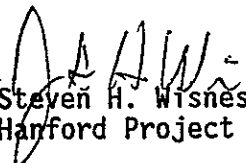
PROJECT W-105 LIQUID EFFLUENT RETENTION FACILITY (LERF) TEST FILL NUMBER 6

Cleanup of the LERF construction area will be starting soon. This will help to ensure that the operations of the LERF basins will not be hampered by unnecessary clutter. Part of the cleanup will include removal of Test Fill Number 6. Removal will begin July 27, 1992, if no comments are received.

Data from Test Fill Number 6 has been taken well beyond the required time required to show the exceptional quality of the soil/bentonite liner installed in the LERF basins. The latest data is attached.

If you have any questions regarding the test fill removal, please contact Dana Bryson of the Waste Management Division on (509) 372-0738.

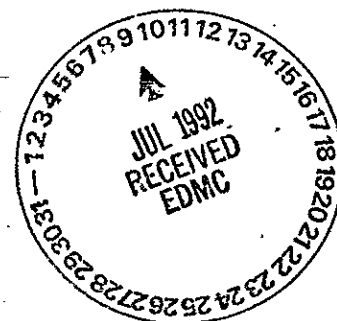
Sincerely,


Steven H. Wisness
Hanford Project Manager

WMD:DCB

Attachment

cc: M. Jaraysi, Ecology, w/att
T. Veneziano, WHC, w/att
D. Kelley, WHC, w/o att
R. Julian, WHC, w/o att
L. Tollbom, WHC, w/o att
B. A. Davis, SWEC, w/o att



REPORT
OF
GEOTECHNICAL INVESTIGATION

TO
KAISER ENGINEERS HANFORD COMPANY
RICHLAND, WASHINGTON

KEH W-105 LERF PROJECT
RICHLAND, WASHINGTON
PROJECT NO. 86-1905

PREPARED
BY
CHEN-NORTHERN, INC.
CONSULTING GEOTECHNICAL ENGINEERS
TRI-CITIES, WASHINGTON

APRIL, 1992

9 2 1 2 3 3 2

Chen-Northern, Inc.

Consulting Engineers and Scientists

2214 North 4th Avenue
PO Box 280
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509 547-1671
509 547-1673 Facsimile

April 30, 1992

Kaiser Engineers Hanford Company
P.O. Box 888
Richland, Washington 99352

ATTENTION: Mr. Stephen Petersen,
W105 LERF Project Manager;
Mr. Larry Gaddis, P.E.,
KEH CQA Officer;
Mr. David McShane, P.E.,
KEH CQA Officer

SUBJECT: Summary Report of Test Fill Observation and
Construction Materials Testing;
KEH W-105 LERF Project,
Hanford Federal Reservation, Washington
Chen-Northern Project No. 86-1905

Gentlemen:

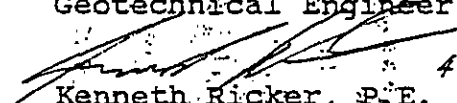
In accordance with the criteria set forth in Kaiser Engineers Hanford Company (KEH) Purchase Order Number B 2018, we have completed the testing and observation of three soil-bentonite composite test fills constructed for the W-105 Liquid Effluent Retention Facility (LERF). In addition, we have completed a brief summary of LERF construction test data and a comparison of that data with the data obtained from the test fills.


The report which follows represents the last of a series of reports concerning the project. This report summarizes the testing and observations which have occurred between February of 1990 and April of 1992. During that time, the soil-bentonite liner project was designed, tested, and constructed. Observation of the design test fill was continued through April 3, 1992.

Should you have any questions regarding this report, please contact us at your convenience.

Respectfully Submitted,
CHEN-NORTHERN, INC.


Brian J. Williams, P.G.
Geotechnical Engineer


Kenneth Ricker, P.E.
Geotechnical Engineer

11-28-92
A member of the  Hill Group

1.0 PROJECT BACKGROUND

1.1 Introduction

At the Hanford site near Richland, Washington, low level radionuclide and stable chemical wastes were previously introduced directly into the soil column. The present U.S. Department of Energy (DOE) policy requires that soil column disposal be discontinued and that wastes be minimized and treated in accordance with state and federal guidelines. An integral part of this new treatment process at the Hanford Site is the construction of a 19.5 million gallon surface impoundment, the LERF Facility. LERF is a permitted RCRA facility consisting of three 6.5 million gallon basins intended to provide interim storage for liquid mixed wastes. Each basin includes a soil-bentonite bottom liner placed on the subgrade soil, followed by a synthetic liner system, piping, leachate collection system, and a floating mechanically tensioned cover.

1.2 Governing Regulation

The regulations directly affecting design and construction of the LERF are Chapter 173-303 ("Dangerous Waste Regulations") of the Washington Annotated Code (WAC)¹. These regulations are based upon RCRA Subtitle C technology². The requirements set forth in the WAC state in part, that the impoundment shall have a liner "that is designed, constructed, and installed to prevent any migration of wastes out of the impoundment to the adjacent subsurface soil or groundwater or surface water during the active life of the impoundment". This was interpreted by state officials to include the Subtitle C requirement of a 3 foot thick soil-bentonite liner having a coefficient of permeability of less than 1×10^{-7} cm/sec. The 1×10^{-7} cm/sec criterion is a current industry standard for soil liners. The entire testing program was formulated to provide design data and construction quality assurance data which would result in the construction of production soil-bentonite liners meeting the coefficient of permeability criterion.

2.0 LABORATORY TESTING PROGRAM

2.1 Design Laboratory Testing

Upon selection of a soil borrow source (the McGee Ranch Site), initial laboratory testing was conducted to determine material characteristics on which to base preliminary design³. The initial testing included establishment of moisture-density characteristics for the native soil and soil-bentonite combinations ranging from 4% to 16% bentonite, testing of shear strength characteristics of soil-bentonite combinations, and flexible membrane triaxial permeability testing of soil-bentonite combinations.

Initial laboratory testing indicated that a minimum bentonite

content of 8% (by dry weight) would be necessary to achieve a permeability of less than 1×10^{-7} cm/sec. Subsequent laboratory testing and engineering analysis also indicated that soil-bentonite combinations with up to 16% bentonite would be stable on the planned 3:1 slopes, but that the higher bentonite content combinations would become unstable and difficult to work with.

After initial design and testing were performed, an alternate borrow source was selected by KEH. The alternate borrow source had been investigated by others⁴. The alternate site investigation included establishment of a minimum bentonite content for mixing into an amended soil liner. The soils were similar to those originally investigated by Chen-Northern, but some differences were encountered. The laboratory testing program performed on the original borrow source was then repeated for the new borrow source.

3.0 FIELD TESTING PROGRAM

3.1 Establishment of Field Testing Program

After the initial design and laboratory testing, it was decided by KEH that the only reasonable course of action for soil liner design would be to construct a series of test pads using several soil-bentonite combinations. Each test pad was to be constructed using the same construction techniques and equipment. In addition, it was planned that if test pad construction and testing were successful, the construction equipment and techniques used for test pad construction would also be used in construction of the full scale liners. The initial construction techniques and equipment were selected by KEH based upon design input from KEH Design personnel, Chen-Northern, and others. Detailed documentation of the construction techniques and equipment was the responsibility of KEH personnel.

The testing program for the test pads included laboratory and in-place moisture-density tests (ASTM D698, WSDOT 609, ASTM D1556, ASTM D3017), liquid and plastic limits tests (ASTM D4318), and grain-size distribution tests (ASTM C138, ASTM C117, and ASTM D422). In addition, laboratory triaxial permeability tests were also planned for relatively undisturbed samples obtained from the test pads (ASTM D5084, Corps of Engineers EM 1110-2-1906 Appendix VII).

After evaluating the planned testing program and recent literature regarding permeability testing of liners and test pads,^{5,6,7,8} it was determined by KEH that a large-scale field permeability test was required to most accurately model the permeability of the test pads. This decision was based upon recent research which indicated that small laboratory specimens of liners (i.e. shelly tube samples) could often overlook a group of macroscopic defects built into the liner. The small specimens could therefore present an inaccurate representation of actual liner performance. The test

method selected for large scale testing was the Sealed Double Ring Infiltrometer (SDRI)⁹. The SDRI is currently referenced under ASTM test method D5093. At the time of selection, the SDRI was not a standard ASTM test method.

The test program was also evaluated to determine if comprehensive construction quality assurance could be performed on the bentonite mixing process to insure that a minimum bentonite content was added to all of the borrow materials. Conventional means of controlling the composition of the soil-bentonite mixture include bulk measurements of pounds of bentonite over a certain ground mixing area, gross percentage of sand and bentonite measured over a day or week of production, or some type of beltline weighing method. These methods were evaluated by KEH and Chen-Northern engineers and were deemed inadequate, considering the available mixing technology, the technical needs of the planned facility, and the necessary degree of quality control. Conventional measuring methods simply did not provide a sufficient factor of safety in regard to proper bentonite content. Therefore, an end-of-belt compliance testing method was researched. Several methods were reviewed, including x-ray diffraction and chemical titration methods. Because of the relatively low cost, apparently acceptable accuracy, and relatively quick turnaround time for test results, a titrative chemical test (methylene blue titration)¹⁰ was selected. The methylene blue test is not represented by an ASTM standard, but is used widely in the refractory industry for controlling the amount of bentonite in foundry sand composites. Our testing program¹⁰ demonstrated the methylene blue test to reliably predict the bentonite content to within ± 0.5 percent.

3.2 Test Pad Construction Protocol

Based upon previous KEH and Chen-Northern experience with mixing efficiency using various types of equipment (and the difficulty obtaining any reasonable product uniformity), the test pad construction specifications were written to include pugmill mixing to obtain the maximum degree of product uniformity. Without preliminary data regarding the potential uniformity of the as-mixed material, the specifications also included the use of a bentonite content over the minimum content determined in the laboratory. The excess bentonite was chosen because of Chen-Northern experience indicating that an excess amount of 50% usually provided a mix wherein all of the material would meet the minimum content specifications. A sand-bentonite combination using 12% bentonite was selected as the target mix. A mix containing 14% bentonite was also selected for comparison purposes.

The first mixing performed indicated that the 50% excess may not have been sufficient to guarantee that all of the mix had at least 8% bentonite. Subsequent mixing by a second contractor was successful in obtaining a reasonably uniform mix, but the target bentonite content remained 12%.

7
2
1
3
5
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3
7

The test pad program included construction of three test pads, two with bentonite contents of 12% and one with a bentonite content of 14%. One test pad was constructed with the 12% bentonite mixture supplied directly from the pugmill, and was designated Test Pad No. 3. The other two test pads were constructed with 12% and 14% mixes which had undergone a minimum 24 hour stockpile seasoning period. Stockpiling was used because of the time necessary for bentonite content testing. The 12% mix from stockpiling was designated Test Pad No. 6, and the 14% mix was designated Test Pad No. 7. Based upon preliminary laboratory permeability test data, the design mix of 12% bentonite with 24 hour curing time was selected for use as the full-scale project material.

3.3 Test Pad Testing Protocol, Routine Tests

Prior to construction of the test pads, the mixed sand-bentonite materials for each test pad were tested randomly by KEH at the end of the pugmill, in the stockpile immediately following stockpiling, or during placement on the test pad. Each sample was tested for bentonite content, gradation, and liquid and plastic limits. The gradation and liquid/plastic limits tests were performed primarily as rapid indicator tests to confirm that the borrow materials and final product had not markedly changed from the design materials. The bentonite content (methylene blue) testing was performed as an acceptance test.

Each test pad covered an area measuring about 50 X 80 feet. They were constructed using an initial 12 inch lift thickness, with subsequent lifts of 6 inches until the full 36 inch thickness was achieved. Each lift was tested for acceptance using moisture and density control. The basis for the test pad moisture-density relationships were the most current series of WSDOT 609 tests, which were carried out immediately prior to test pad construction. For the 12% mix, the maximum WSDOT 609 density was determined to be 105.1 pounds per cubic foot, at an optimum moisture content of 19.0%. Based upon a series of WSDOT 609 (moisture-density relationship) tests for a range of bentonite contents, the moisture content criteria was set at 19.5 to 24.5%. Minimum acceptable density was arbitrarily set at 92% of WSDOT 609 density. Each lift was tested for moisture and density compliance in at least three random areas. Areas with test results outside the specifications were removed and replaced or reworked.

Based upon the accuracy of the bentonite content tests, the range of acceptable shear strength to maintain slope stability and the anticipated minimum acceptable bentonite content to achieve the coefficient of permeability criterion, the bentonite content for the 12% production mix was specified to range from 11.5% to 14.5%.

The density, moisture content, and bentonite content test results for the test pads are summarized in Table I.

TABLE I. TEST FILL DATA SUMMARY, ROUTINE TESTS

| TEST PAD NUMBER | 3 | 6 | 7 |
|---|-------|-------|------|
| A. Average Bentonite Content, By %, As Determined By Methylene Blue Testing | 12.9 | 12.5 | 14.2 |
| Standard Deviation, % | * | 0.7 | * |
| Number of Tests (A) performed | 7 | 6 | 7 |
| B. Average Moisture Content, By % | 19.3 | 21.8 | 21.5 |
| Standard Deviation | * | 2.20 | * |
| C. Average Dry Density of Passing tests, By Pounds Per Cubic Foot | 100.8 | 101.5 | 97.9 |
| Number of tests (B & C) performed | 20 | 20 | 20 |
| * Insufficient data provided to perform standard deviation calculation | | | |

3.4 Test Pad Testing Protocol, Permeability Tests

3.4.1 Laboratory Permeability Tests

Immediately upon completion of each test pad, three relatively undisturbed samples were obtained from each test pad by pushing a california type ring sampler into the surface of the test fill. The sample sites and depths were randomly selected. The samples were tested in a flexible wall triaxial permeameter in accordance with the Corps of Engineers and ASTM test methods. The test results are listed in Table II.

TABLE II. TEST PAD DATA SUMMARY, LABORATORY PERMEABILITY TEST

| TEST PAD NUMBER | 3 | 6 | 7 |
|--|--|--|--|
| A. Coefficient of Permeability, As Determined By Flexible-Wall Permeameter, In Centimeters Per Second | 1×10^{-8} 3×10^{-8} 2×10^{-8} | 2×10^{-8} 1×10^{-8} 2×10^{-8} | 2×10^{-8} 5×10^{-9} 1×10^{-8} |
| Average Value: | 2×10^{-8} | 2×10^{-8} | 1×10^{-8} |

3.4.2 SDRI Test Results

After completion of each test pad, a SDRI apparatus was installed. Details of the apparatus and test method were presented in a previous report⁹. For the purposes of this report it is sufficient to reiterate that the inner ring measures 30 inches square and a constant water depth of 12 inches was maintained throughout the tests. Each test pad was monitored for a different period of days, depending upon when the test pad was completed. Because of project space requirements, Test Pads No. 3 and 7 were dismantled on September 3, 1991. These two test pads were not representative of the design mix and curing time selected for construction of the full scale liner, but did serve to establish a field of data for further work at the site. The monitoring of Test Pad No. 6 was completed on April 3, 1992.

As previously reported⁹, there is considerable debate among practitioners and researchers concerning the method for calculating a coefficient of permeability from SDRI data. That debate centers around the influence of soil swelling and soil suction. Reliable methods for measuring the influences of soil swell and soil suction in field tests have not been developed. As a result, the method of calculation more commonly used by practitioners neglects these influences, thereby yielding a conservative value. We elected to use the conservative method for our calculations based upon the logic that if it yielded coefficient of permeability values meeting the acceptance criterion, then it is not necessary to consider and defend the theories associated with the influences of soil swell and the suction head.

Simply as a matter of interest, an approximation for the coefficient of permeability was also made using our best estimate of the influences related to soil swell and suction. A summary of that exercise is presented later in this section.

The coefficient of permeability calculation is based upon measurements of fluid infiltration made on numerous days after the start of the tests. At each test interval, the amount of fluid lost from the previous interval was measured. The rate of infiltration was then calculated using the equation:

$$I = Q \div (A \times t), \text{ where}$$

I = infiltration rate in centimeters per second

Q = flow rate, in milliliters per second,

A = area of the SDRI inner ring in square centimeters,

t = elapsed time in seconds.

A plot of the incremental and cumulative infiltration rates verses time are included as Figures 1 and 2. Converting the infiltration rate to the coefficient of permeability is accomplished by dividing the infiltration rate by the gradient. This calculation is not however straightforward, since one has to determine or assume a gradient based upon the depth of wetting. For purposes of simplicity and conservancy, we assumed that the infiltrate had penetrated 6 inches. That assumption is based upon the tensiometer data which showed that the wetting front had not penetrated 6 inches, and that at least 10 centibars of soil suction was observed at depths as shallow as 6 inches at the time of the last reading of each SDRI apparatus.

Using a constant wetting depth if 6 inches, the coefficient of permeability was calculated and plotted for each test pad using two different time references. Based upon the data shown in the Figures 3 and 4, the calculated coefficient of permeability for the last set of data from each of the test pads is presented in Table III.

The first plot, Figure 3, presents the incremental coefficient of permeability values, calculated based on the time interval between each of the set of data readings. This plot tends to be sensitive to minor environmental influences such as temperature and barometric fluctuations and release of air vapors from the soil into the SDRI; also referred to as "burping effects". The second plot, Figure 4, presents the cumulative coefficient of permeability based time intervals referenced to the date each test began. That plot uses successively longer time intervals, thereby tending to averaging out the environmental influences that produce data scatter in Figure 3.

Table III. COEFFICIENTS OF PERMEABILITY OF TEST PADS FROM SDRI DATA

| TEST PAD NUMBER | 3 | 6 | 7 |
|---|----------------------|----------------------|----------------------|
| A. Incremental Coefficient of Permeability, In Centimeters Per Second, Using SDRI Data And Assumed Wetting Front Depth Of Six Inches, | 3.2×10^{-8} | 2.1×10^{-8} | 1.3×10^{-8} |
| B. Cumulative Coefficient of Permeability, In Centimeters Per Second, Using SDRI Data And Assumed Wetting Front Depth Of Six Inches | 3.5×10^{-8} | 2.2×10^{-8} | 1.5×10^{-8} |

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The method of calculation presented above, while providing a conservative number for regulatory requirements, does not address all of the phenomena occurring at the test pads. The primary factors which the previous calculation method and laboratory testing cannot consider are the amount of infiltration which contributes to swell, and the long-term time effects of that swell. Laboratory tests are usually not run for a time period sufficient to allow for completion of swelling effects. In addition, laboratory tests are not usually performed at the very low gradients which occur in a strict leachate-controlled system. (The LERF project will control any leachate with a fluid detection and pumping system.)

When the effects of swell are considered, the amount of infiltrate contributing to vertical fluid migration decreases, which results in a corresponding decrease in the calculated coefficient of permeability. Based upon research by others,¹¹ it is expected that the planned 18 foot depth of water in the basins will not be sufficient to stop swelling effects of the bentonite in the liner. Therefore, a calculation method which attempts to account for swell effects will probably yield a coefficient of permeability that more accurately represents the actual value than the calculation method used for the values presented in Table III. A portion of the infiltrate becomes attached to the bentonite particles, resulting in the swelling phenomenon. Survey data indicates at least 2 inches of vertical swell occurred at each of the SDRI tests while they were in progress.

Based upon our interpretation of the field and laboratory test data we estimate about 95% of the fluid that infiltrated the liner became attached to the bentonite and was therefore associated with soil swelling. Only about 5% of the infiltrate is estimated to be attributable to flow through the wetted depth.

Based on our estimation of swell effects, the coefficient of permeability of the soil-bentonite liner, is estimated to be about 1×10^{-9} centimeters per second.

4.0 COMPARISON OF FULL SCALE W-105 LINERS CONSTRUCTION TEST DATA WITH TEST PAD DATA

We summarized all of the bentonite content test, moisture, and density data from the construction of the W-105 liners provided to us by KEH personnel. The arithmetic mean and (when provided sufficient data) the standard deviation of the results were tabulated. The results are presented in Table IV.

TABLE IV. CONSTRUCTION TEST DATA

| | |
|---|-------------|
| A. Average Bentonite In Stockpile, By %, As Determined By Methylene Blue Testing | 12.9 |
| Standard Deviation, % | 0.80 |
| Range of Specification, By % | 11.5 - 14.0 |
| Number of Tests Representing A | 555 |
| B. Average Dry Density of Passing Tests, By Pounds Per Cubic Foot | 101.3 |
| Minimum Specified Dry Density, By Pounds Per Cubic Foot | 96.7 |
| C. Average Moisture Content, In-Place, By % | 21.0 |
| Range of Specification By % | 19.5 - 24.0 |
| Number of Tests Representing B & C | 548 |

A simple comparison of the construction data and the test pad data indicates that the test pads and the full scale W-105 liners were constructed to nearly the same standards of bentonite content, moisture content, and dry density.

5.0 CONCLUDING OPINIONS

Based upon the test data presented herein and the numerous observations that were made over the duration of the project, we present the following concluding opinions.

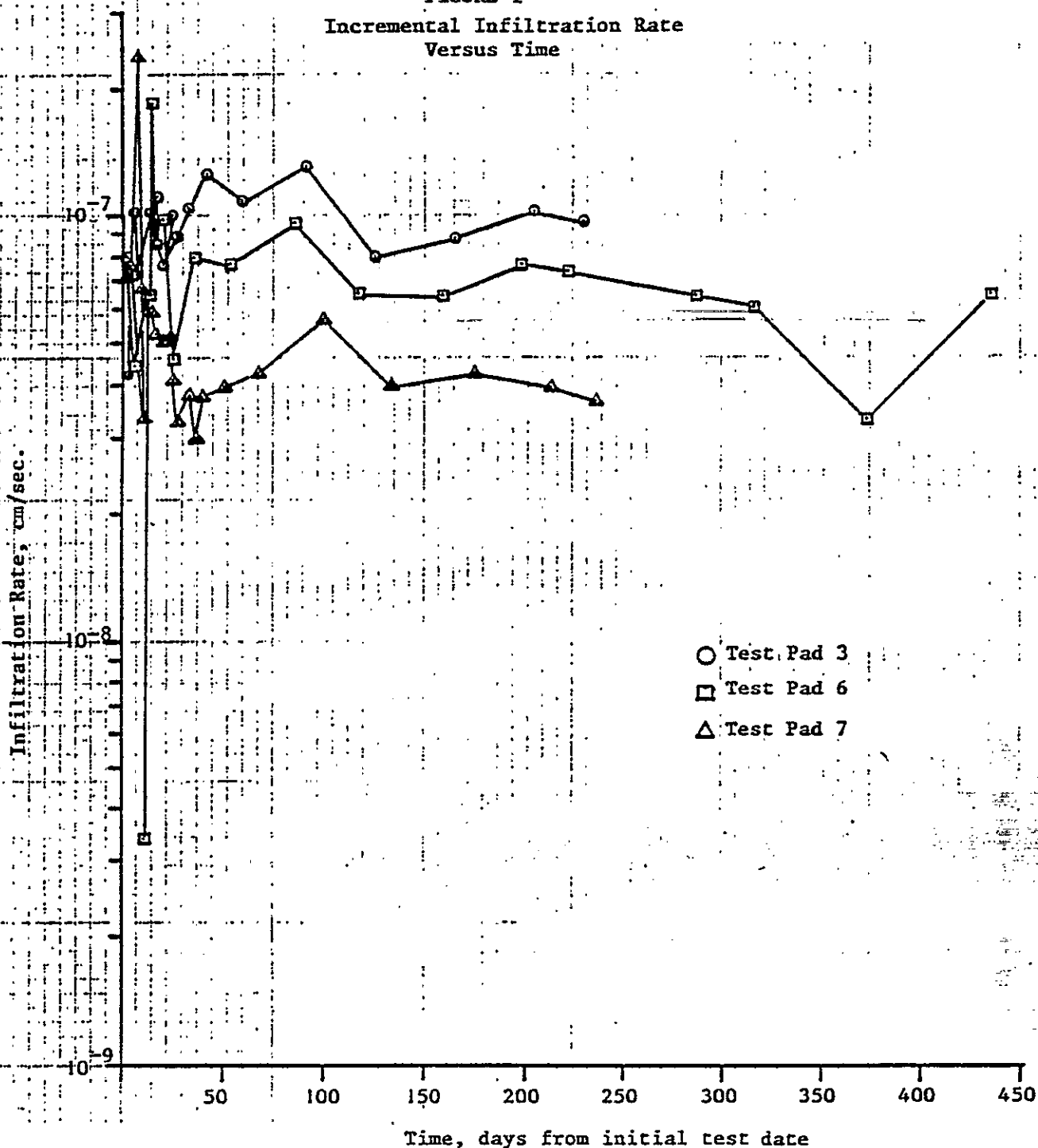
1. The SDRI tests performed on each of three test pads demonstrated that all three of the test pads had a coefficient of permeability, which by conservative estimates, was nearly one order of magnitude less than the allowable value of 1×10^{-7} cm/sec.
2. The method used to calculate the coefficient of permeability from the SDRI tests is conservative because it ignores the influences associated with soil swelling and soil suction. It is probable the actual coefficients of permeability of the test pads were in the range of 1×10^{-9} cm/sec.

3. The combination of bentonite content, moisture and dry density control proved to be suitable test methods for constructing liners meeting the coefficient of permeability requirement.
4. Results of the bentonite content, moisture and field dry density tests demonstrated that a relatively uniform material was placed and compacted on both the test pads and full scale W-105 liners.
5. The specification that the full scale W-105 liners have a coefficient of permeability of 1×10^{-7} cm/sec or less was met and probably exceeded by about one order of magnitude or more.
6. The test data obtained in the test pad program and in the construction of the full scale liners agreed very well, indicating that the full scale liners should perform in accordance with the results of the test pads.

REFERENCES

1. Washington Annotated Codes, Chapter 173-303, as updated March 7, 1991.
2. U.S. Environmental Protection Agency, (1985), "Draft Minimum Technology Guidance on Double Liner Systems for Landfills and Surface Impoundments", EPA/530-SW-85-014.
3. Chen-Northern, Inc. Report to Kaiser Engineers Hanford Company, (1990), "Design Report, W-105, 242-A Evaporation and Purex Interim Retention Basins".
4. Golder Associates, Inc., (1990), "Design Report Project W-025 Radioactive Mixed Waste (RMW) Land Disposal Facility Non-Drag-Off", report prepared for Westinghouse Hanford Company under U.S. Department of Energy Contract No. DE-AC06-89RL11615.
5. Alonso, E. E., Gens, A., and Hight, D. W., (1989), "Special Problem Soils-General Report, (Session 5), Proceedings, Ninth European Conference on Soil Mechanics and Foundation Engineering, International Society of Soil Mechanics and Foundation Engineering.
6. Trautwein, S. J., and Williams, C. E., (1990) "Performance Evaluation of Earthen Liners", Waste Containment Systems: Construction, Regulation, and Performance, American Society of Civil Engineers Geotechnical Special Publication Number 26.
7. Daniel, D. E., (1990), "Summary Review of Construction Quality Control for Compacted Soil Liners", Waste Containment Systems: Construction, Regulation, and Performance, American Society of Civil Engineers Geotechnical Special Publication Number 26.
8. Day, S. R., and Daniel, D. E., (1985), "Hydraulic Properties of Two Prototype Clay Liners", Journal of Geotechnical Engineering, American Society of Civil Engineers.
9. Chen-Northern, Inc. Report to Kaiser Engineers Hanford Company, (January 14, 1990), "Permeability Testing of the W-105 Test Fill Sections Using the Sealed Double Ring Infiltrometer".
10. Chen-Northern, Inc. Report to Kaiser Engineers Hanford Company, (January 14, 1990), "Methylene Blue Evaluation of the W-105 Soil-Bentonite Composite".
11. Chen, F. H., "Foundations on Expansive Soils," Elsevier Science Publishing Company, 1988.

FIGURE 1
Incremental Infiltration Rate
Versus Time



Kaiser Engineers Hanford
Richland, Washington

W-105 Liner Test Pads
Hanford Site, Washington

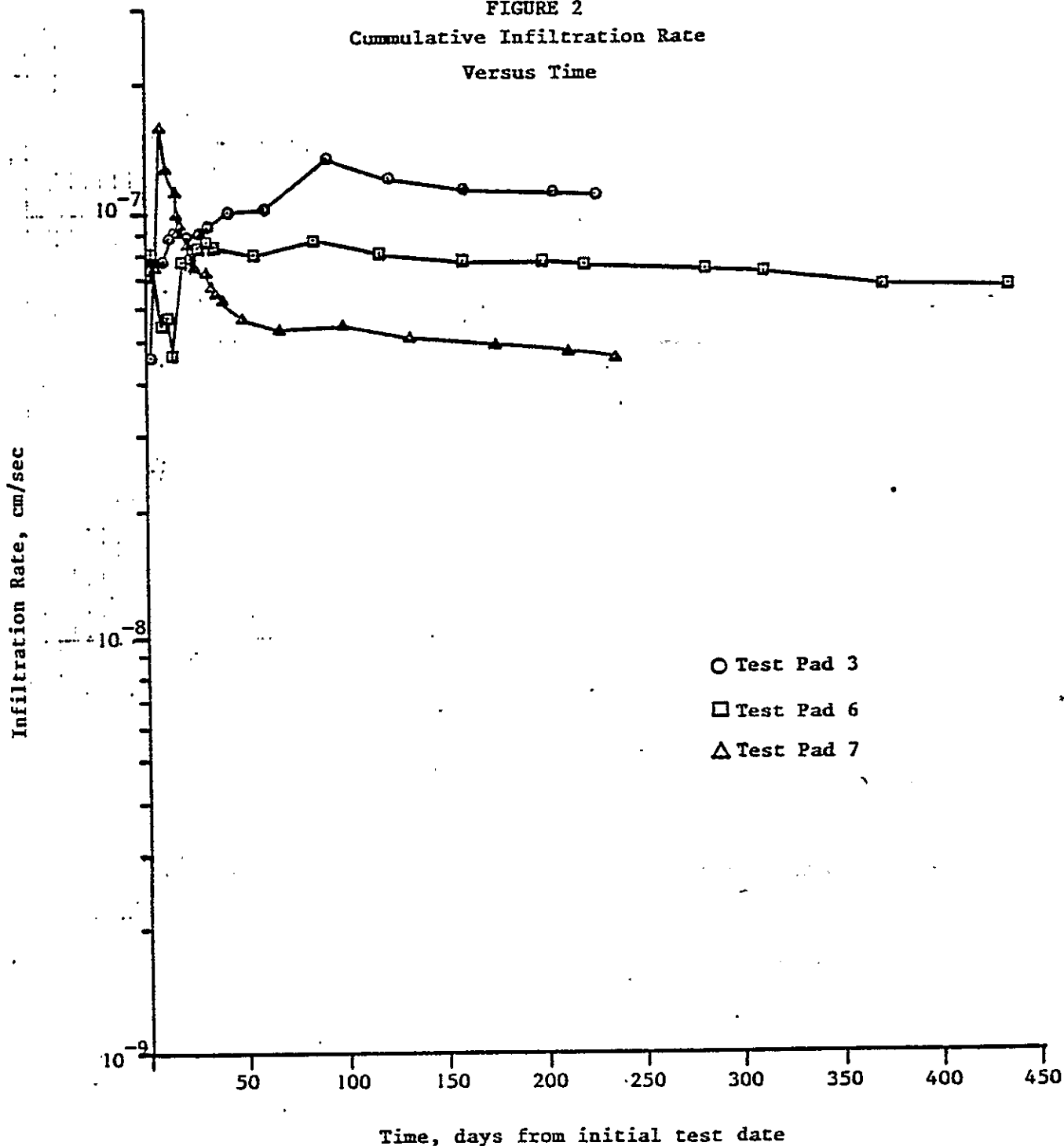
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Pasco, Washington

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FIGURE 2
Cumulative Infiltration Rate
Versus Time



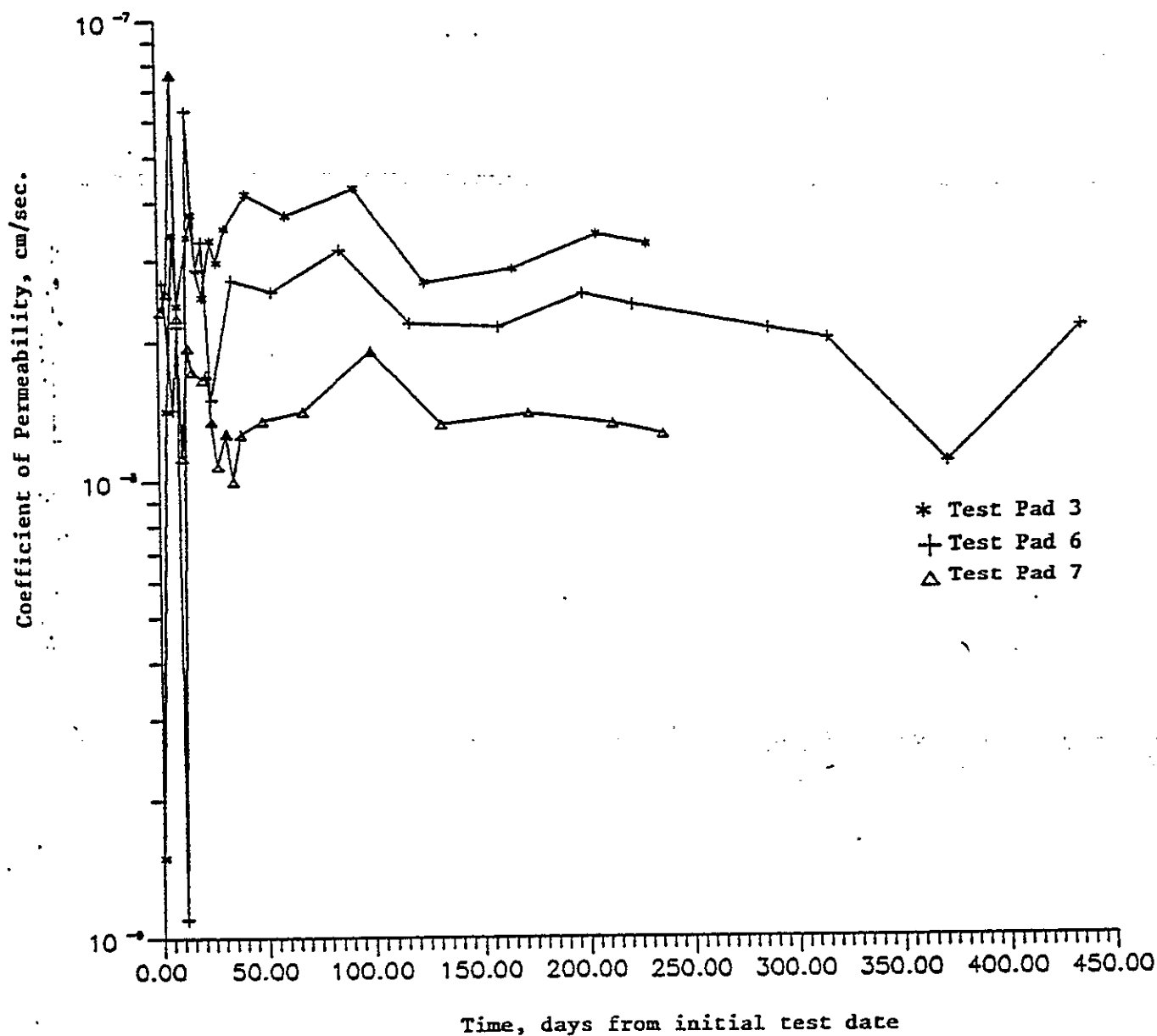
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FIGURE 3
Incremental Coefficient of Permeability
Versus Time



Note: Calculation for coefficient of permeability assumed wetted depth of 6 inches throughout the testing period.

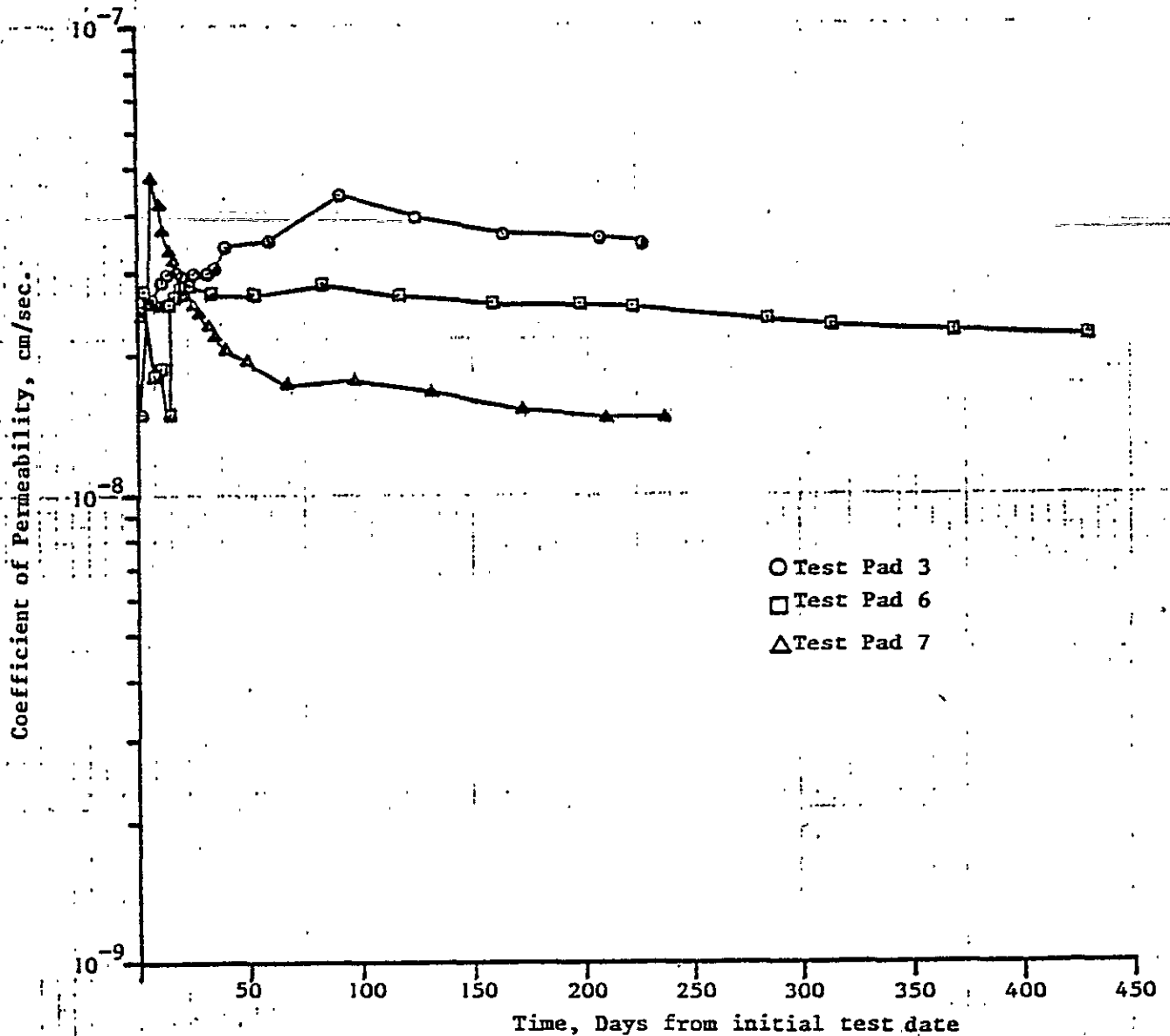
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Richland, Washington

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FIGURE 4
Cumulative Coefficient of Permeability
Versus Time



Note: Calculation for permeability assumed wetted depth of 6 inches throughout the testing period.

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Richland, Washington

W-105 Liner Test Pads
Hanford Site, Washington

Chen-Northern, Inc.

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Pasco, Washington

JOB NO. 86-1905

CORRESPONDENCE DISTRIBUTION COVERSHEET

Author

S. H. Wisness, RL

Addressee

D. B. Jansen, Ecology

Correspondence No.

Incomming
Letter: 9204804

Subject: PROJECT 1-105 LIQUID EFFLUENT RETENTION FACILITY (LERF) TEST FILL
NUMBER 6

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